

Improving Daylighting and thermal performance in SPORTS HALL buildings with phase change materials (PCM) to reduce energy consumption

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Abstract:

The research paper proposes a model for using phase change materials to improve the visual and thermal performance of indoor sports halls, with the goal of achieving maximum natural lighting during the day and improving thermal performance, thus optimizing energy consumption. This is accomplished by employing (PCM Translucent) for window openings and PCM paraffin for wall thermal insulation.

To achieve the research's goal, a sports building in Cairo with an area of 4028 m² with gymnastics and basketball halls was chosen. The value of daylight, thermal performance, and rate of energy consumption of the case study were all measured using simulation programs. The findings revealed that the internal spaces do not fulfill measuring norms. LEED, whether in terms of daylight quality or thermal performance, and the analysis showed that the northern façade of the building obtains the greatest quantity of sunlight, while the southern façade is the most exposed to the sun's harmful rays.

Experiments were conducted to determine the best ratio of (WWR%) openings that could be utilized in the northern façade and ceilings to achieve maximum natural lighting during the day using the transparent PCM material and the simulation program to the different widow wall ratios (25, 35, and 45%). The results showed that as the percentages of openings in the wall and ceiling increased, but when they increased 45% of the side effect "light scattering" began to appear, the results showed improved thermal performance by using (PCM paraffin) as a thermal insulator to insulate the southern façade.

Comparing the simulation results of the gymnasium spaces before and after development revealed a clear improvement, with the value of daylight improved by 163%, the temperature improved by 27%, the humidity improved by 27%, and solar radiation improved by 70%, energy consumption was reduced by 67% As a result.

Keywords:

Sports Hall, Daylighting, window wall Ratio (WWR%), phase change materials (PCM), energy consumption.

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